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(54) **Control arrangement for central heating or cooling system**

(57) There is disclosed a central heating or cooling system having a microprocessor (30) for control purposes. The microprocessor is programmed to sum energy consumption of the system over a predetermined period, and in a preferred arrangement to modify the control function to maintain energy consumption within a user chosen budget. Control and cost parameters can be entered via a keypad (50) and displayed (52, 53).

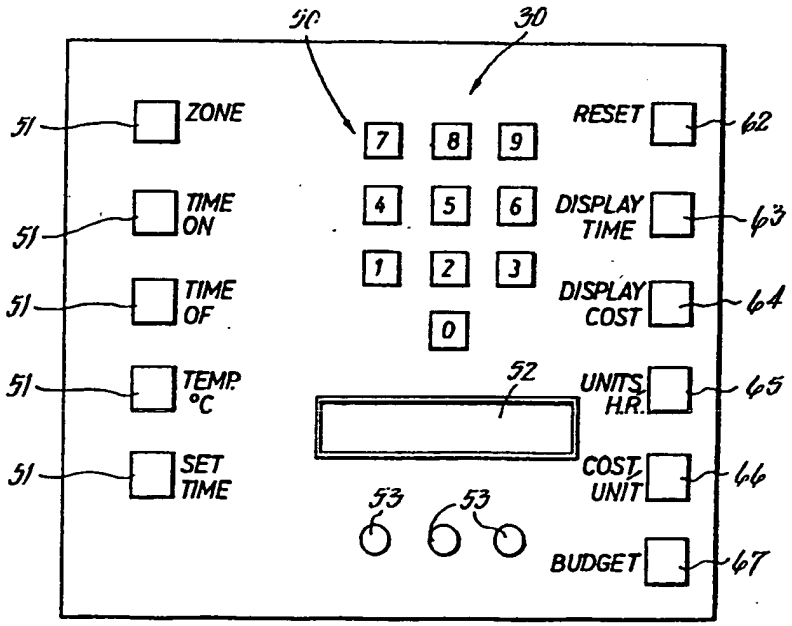

FIG.3

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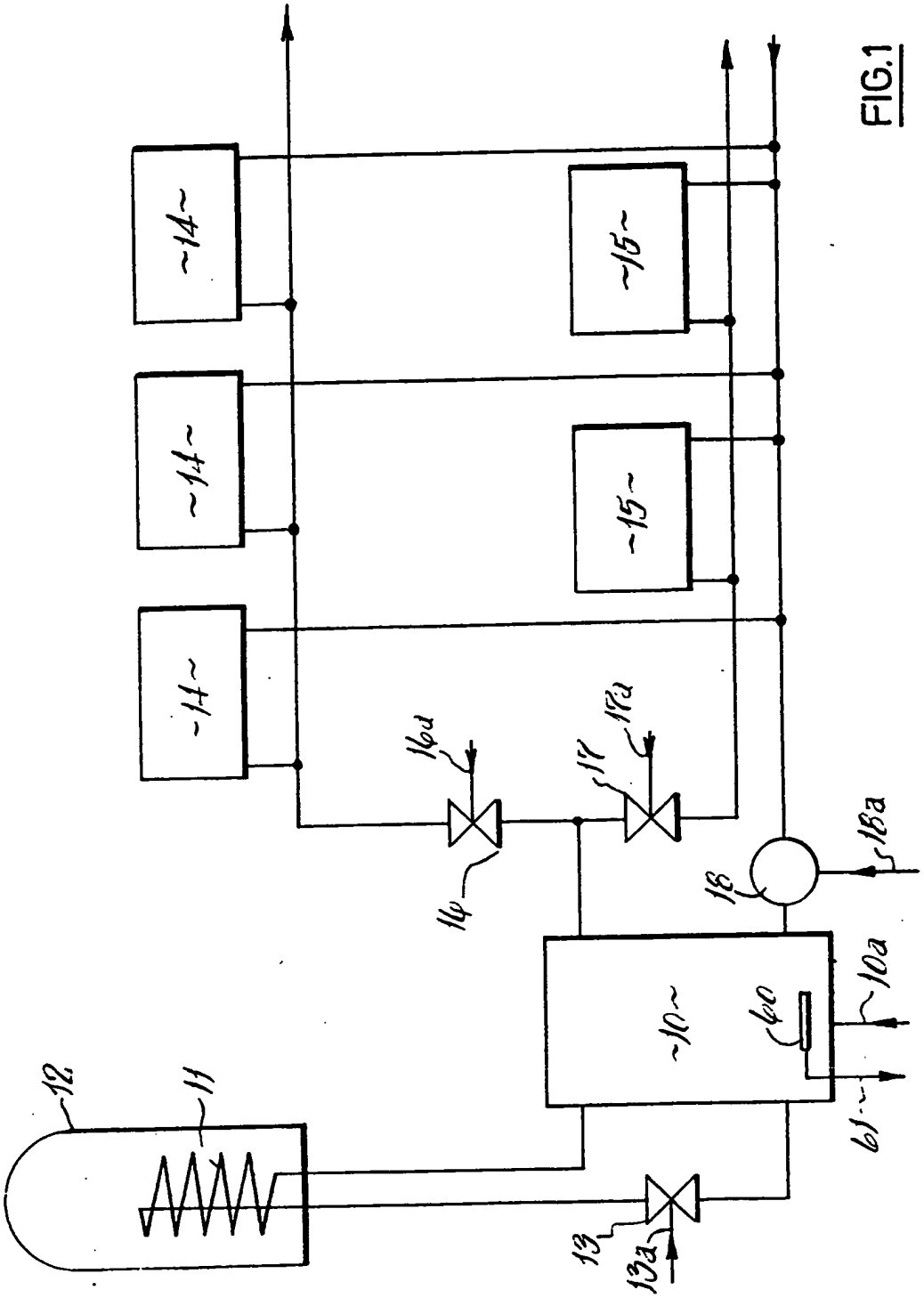
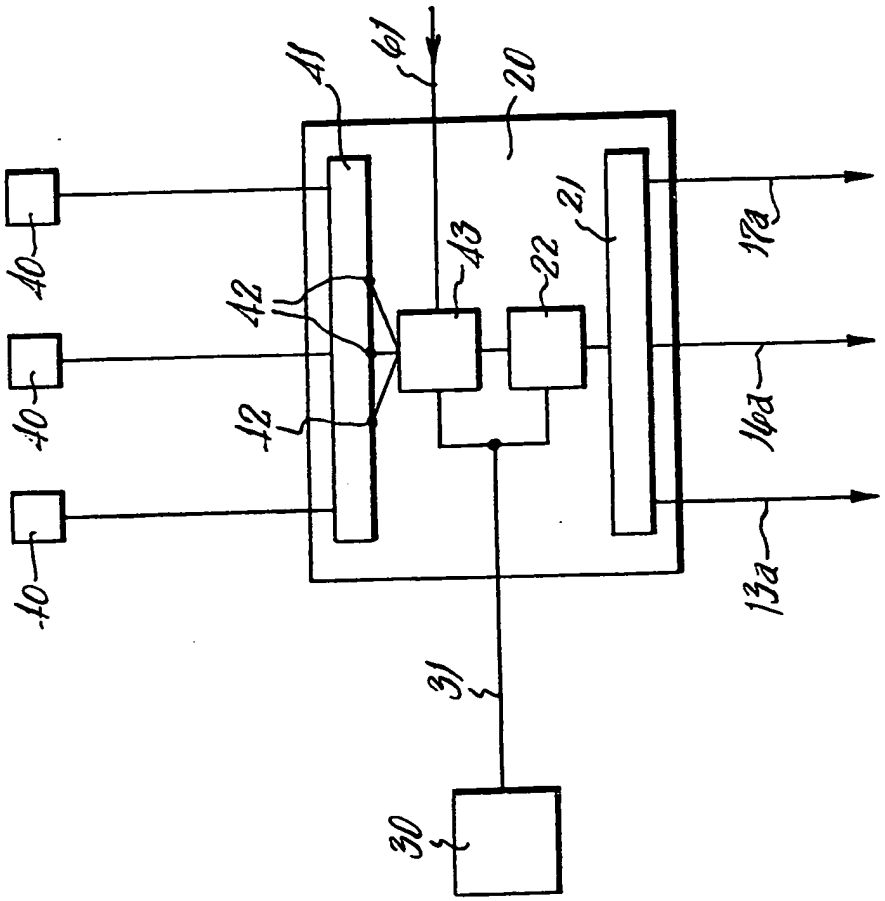


FIG.1

FIG.2



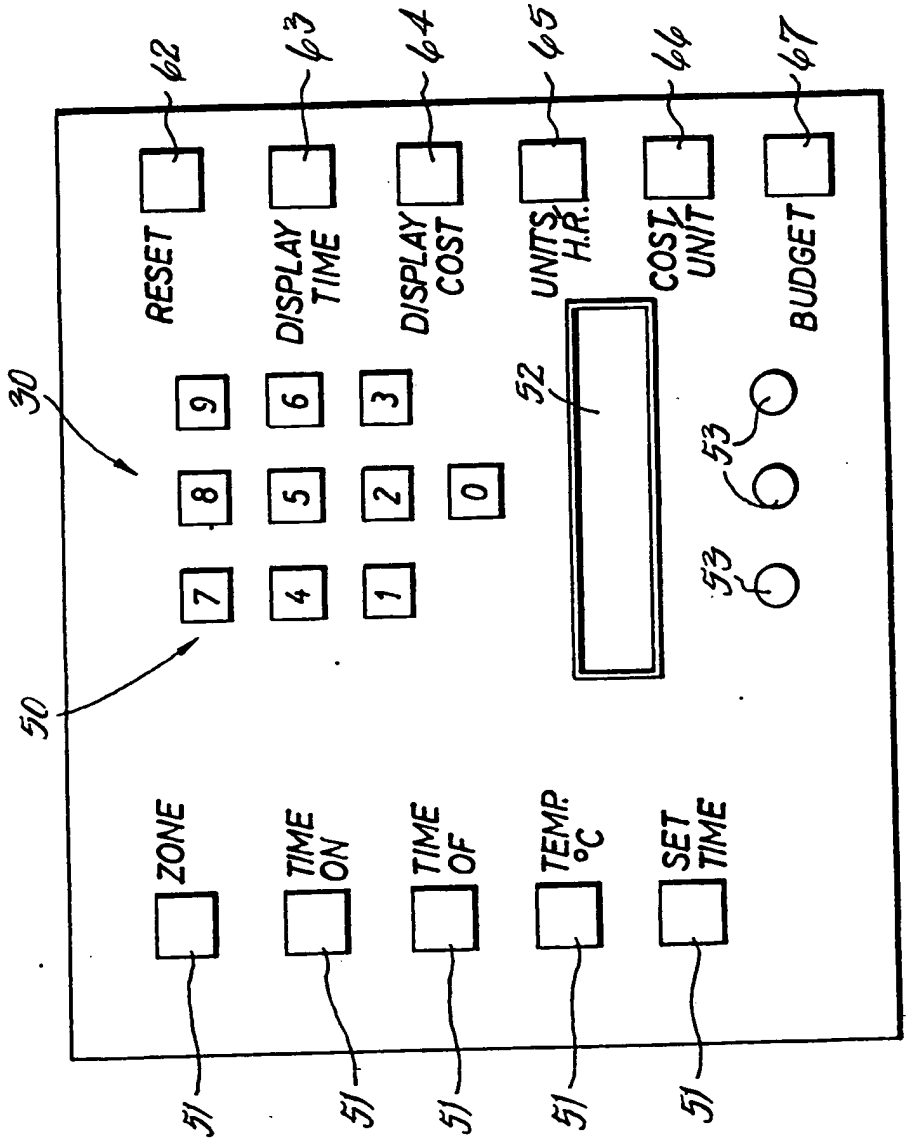

62
63
64
65
66
67
RESET
DISPLAY TIME
DISPLAY COST
UNITS $ H.R.
COST/ UNIT
BUDGET
30
9
6
3
8
5
2
0
7
4
1
52
53
53
53
50
ZONE
TIME ON
TIME OF
TEMP. °C
SET TIME
51
51
51
51
51

FIG.3

SPECIFICATION

Control arrangement for central heating or cooling system

This invention concerns a control arrangement for a central heating or cooling system which may be domestic, commercial or industrial and of the kind (hereinafter termed "of the kind referred to") including an energy consuming unit.

A typical system of the kind referred to is a domestic central heating system comprising an oil or gas-fired boiler adapted to supply heated water to three zones. The first and second zones each comprise a plurality of central heating radiators located on the ground floor and first floor of the house respectively whilst the third zone comprises the primary heating coil for a cylinder for domestic hot water supply. Each zone is connectable to receive heated water from the boiler by means of a motor driven zone control valve. A pump is provided for the forced circulation of heated water through the first and second zones whilst water circulation through the third zone is gravity dependent.

As described in our co-pending British Patent Application No. , for example, such a central heating system is advantageously controlled by a microprocessor into which the user can key desired operating times and temperatures for each zone to constitute a control programme.

The present invention is based upon the possibility of utilising the power of the microprocessor for more extensive monitoring and control functions.

According to the present invention, a central heating or cooling system of the kind referred to and which includes a microprocessor or the like for control purposes is characterised in that the microprocessor or the like is programmed to sum consumption of energy by the energy consuming unit during a predetermined period.

In a preferred arrangement, a user can key into the microprocessor a budget expenditure for fuel and the microprocessor is programmed to monitor fuel consumption against budget expenditure and adjust the control programme in accordance with predetermined algorithms to maintain fuel consumption within budget.

The invention will be further apparent from the following description, with reference to the several figures of the accompanying drawings, which show, by way of example only, one form of control arrangement for a typical domestic central heating system embodying the invention.

Of the drawings:—

Figure 1 is a diagrammatic representation of the major components of the central heating system;

Figure 2 is a block circuit diagram of the control arrangement; and

Figure 3 is a plan view of the control panel to the microprocessor of the arangement.

Figs. 1 and 2 generally show line wiring only and omit earth and return wiring in the interests of clarity.

Referring now to Fig. 1, it will be seen that the central heating system includes an oil or gas-fired boiler 10 which will fire whenever enabled by application of mains voltage on line 10*a* as long as water temperature is below a predetermined safety level of say 82°C set on a cut-out boiler thermostat (not shown). The boiler 10 can, under the influence of gravity, circulate heated water through a coil 11 to heat water for the domestic hot water supply contained within a cylinder 12 provided the zone control valve 13 is held open by application of mains volatage to line 13*a*.

The boiler 10 can also supply heated water to an upstairs heating circuit comprising space heating radiators 14 and/or a downstairs heating circuit comprising space heating radiators 15 when zone control valves 16 and/or 17 are opened respectively by application of mains voltage to lines 16*a* and 17*a* respectively. Circulation of heated water through the upstairs and/or downstairs heating circuit is assisted by a pump 18 which is operated whenever mains voltage is applied on line 18*a*.

Turning now to Fig. 2 it will be seen that a control box 20 is provided which includes solid state switch means 21 adapted to apply or remove mains voltage to selected ones of lines 13*a*, 16*a* and 17*a* under the control of decoding circuitry 22 which receives coded pulses from a microprocessor 30 through line 31.

Transistorised temperature sensing devices 40 are provided for each zone. Two of the devices sense air temperature in desired positions in a downstairs and upstairs room of the house respectively, whilst the third is secured to the wall of the cylinder 12 to sense the temperature of the water therein. The devices 40 are connected to circuitry 41 adapted to give a digital output representative of the sensed temperatures to three ports 42 which can be interrogated in turn by the microprocessor 30 using again the line 31 and further decoding circuitry 43.

The microprocessor 30 will generally be located remote from the boiler house and control box 20 and be connected therewith by a cable containing three cores at most. Two cores are used as a power supply and the third comprises line 31 previously referred to. When the control arrangement is fitted to an existing central heating system, the microprocessor 30 may be

conveniently installed at the site of a redundant room thermostat and utilise the existing cabling to the boiler house.

The microprocessor 30 is provided with both RAM and ROM in known manner and a battery reserve to ensure that stored data in RAM is not lost through temporary interruption of power supply.

The control panel of the microprocessor 30 is shown in Fig. 3 and includes a numeric keypad 50, five function buttons 51, an LCD display 52 and a number of LED indicators 53.

In use the user first presses the "set time" button and keys in current time. He then presses the 'zone" button and keys in the identifying number of the first zone to be programmed. Next the "time on", "time off" and "temperature" buttons are pressed in turn and the start time, top time and required temperature for the selected period keyed in. This process might be repeated to provide a plurality of such periods, some of which may commence and terminate simultaneously throughout the twenty-four hour day. The remaining zones are then programmed in similar manner.

All keyed in values are stored at predetermined addresses in RAM.

A typical programme might be as follows:—

Zone 1—Downstairs Heating

On 6.30	Off 23.00	Temp 20°C
On 23.00	Off 6.30	Temp 10°C

Zone 2—Upstairs Heating

On 22.00	Off 24.00	Temp 20°C
On 6.00	Off 8.30	Temp 20°C

Zone 3—Domestic Hot Water

On 6.30	Off 10.00	Temp 60°C
On 16.00	Off 23.00	Temp 60°C

The ROM of the microprocessor contains software to cause the microprocessor to perform the following operations:—

1. During each period of one second to send coded pulses through line 31 to actuate circuitry 43 to access ports 42 in turn to receive through line 31 temperature data from each of the three zones.
2. To compare the received data with the required data stored in RAM.
3. Whenever the programmed time settings and sensed temperature for each zone both call for heat to send a coded signal through line 31 to actuate circuitry 22 to operate switch means 21 to open the associated zone control valve.
4. Whenever either the programmed time settings or the sensed temperature for each zone calls for no heat to send a coded signal through line 31 to actuate circuitry 22 to operate switch means 21 to close the associated zone control valve.

The zone control valves 13, 15 and 17 include switch means adapted and arranged to apply mains voltage to line 10*a* to fire the boiler 10 whenever any one of them is open and also to apply mains voltage to line 18*a* to operate pump 18 whenever either valve 16 or valve 17 is open.

The LED indicators 53 can be illuminated to show which parts of the system are operating at any time, whilst the LCD display 52 can be used to allow the user to examine any of the preset values of time and temperature by actuation of the appropriate function buttons 51.

In accordance with the invention a probe 60 is provided to detect when the boiler 10 is actually firing. It should be noted that the boiler will not necessarily be firing for all of the time that mains voltage is present on line 10*a*.

The probe 60 is connected by line 61 to circuitry 43 and the microprocessor 30 is programmed to interrogate the probe at say one-second intervals and sum the total time that the boiler has fired since a reset button 62 on the panel of the microprocessor 30 was last operated. This time can be shown on display 52 by pressing a display button 63. A further display button 64 will give a reading of the cost of fuel used if the user has previously input values for consumption of fuel in units per hour and cost of fuel per unit using input buttons 65 and 66 and keypad 50.

The user may, using input button 67, key in a budget expenditure for fuel for say a weekly period and the microprocessor includes programming to monitor actual fuel expenditure and compare it with the budget and, if necessary, modify the user's control programme by shortening times and lowering temperatures in accordance with a predetermined algorithm to

keep expenditure within budget.

The budget figure may be for an entire year when the microprocessor will include algorithms for appropriate allocation of the budget over the fifty-two weeks of the year. When setting up, the microprocessor must be given the date but this can be keyed in as an additional string when setting current time.

It will be appreciated that it is not intended to limit the invention to the above example only, many variations, such as might readily occur to one skilled in the art, being possible, without departing from the scope thereof.

Thus, for example, the microprocessor need not sample the probe 60 through line 31, the probe 60 then being connected directly to the microprocessor, as indeed may other components of the system.

Again, for example, the microprocessor may include a port to receive a printer to enable a user to obtain a print-out of fuel usage and other data to enable the performance of the system as a whole to be monitored and measured objectively, given additional meteorological data.

Additional buttons may be provided on the control panel to set any zone to permanently on or permanently off conditions.

All systems should have overriding controls to call for heat in frost conditions.

CLAIMS

1. A central heating or cooling system of the kind referred to and which includes a microprocessor or the like for control purposes characterised in that the microprocessor is programmed to sum consumption of energy by the energy consuming unit during a predetermined period.

2. A central heating or cooling system according to claim 1, wherein said microprocessor is adapted to enble a user to enter into RAM the cost of an energy unit and a budget expenditure for fuel, and wherein the microprocessor is programmed to adjust the control programme in accordance with predetermined algorithms to maintain fuel consumption within budget.

3. A central heating or cooling system according to claim 2, wherein the period for which budget expenditure is entered is a fraction of a full year.

4. A central heating or cooling system according to claim 3, wherein said period is one week.

5. A central heating or cooling system according to claim 2, wherein the period for which budget expenditure is entered is a full year, the microprocessor being programmed to allocate the budget to the different weeks of the year in accordance with a predetermined algorithm.

6. A central heating or cooling system according to any one of claims 2–5, wherein the system independently controls temperature in plurality of different zones.

7. A central heating or cooling system according to claim 6, wherein said adjustment is effected by adjusting the times for which the system is operative and the temperature to be achieved by the system in the different zones.

8. A central heating or cooling system according to any preceding claim, including a probe adapted to detect when the energy consuming unit is operative, the microprocessor being programmed to interrogate the probe at periodic intervals.

9. A system according to any preceding claim, wherein the energy consuming unit is a gas or oil-fired boiler.

10. A system substantially as described herein with reference to and as illustrated by the figures of the accompanying drawings.

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